

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Signature

Applicant : Barbara D. Kotzias, et al.
Application No. : 09/896,452
Filed : June 29, 2001
Title : LEADFRAME PEDESTALS FOR UNIFORM DIE ATTACH

Grp./Div. : 2827
Examiner : David E. Graybill

Docket No. : 42233/MJM/A717

RESPONSE TO OFFICE ACTION DATED JUNE 19, 2002

Assistant Commissioner for Patents
Washington, D.C. 20231

Post Office Box 7068
Pasadena, CA 91109-7068
November 18, 2002

Commissioner:

In response to the Office action dated June 19, 2002, please amend the above-identified application as follows and re-examine and reconsider the application in view of the amendments and remarks provided.

Enclosed herewith is a petition for a two-month extension of time and the appropriate fee.

AMENDMENTS

In the Claims:

Please cancel claims 2 and 10. Please amend claims 1, 3, 4, 8, 11, 15, 19, and 21-24 as indicated in the attached **Version with Markings to Show Changes Made**. The complete set of pending claims, in amended version, is as follows:

1. (Amended) A method for joining a semiconductor die to a leadframe comprising the steps of:

providing a semiconductor die and a leadframe;

forming at least three pedestals raised above a surface of said leadframe in a mounting area adapted for receiving said semiconductor die attached thereto, each of said pedestals having substantially the same pedestal height;

introducing solder onto said mounting area;

heating to urge said solder to deform and to include an average thickness being at least as great as said pedestal height; and

joining said semiconductor die to said mounting area and urging said solder to solidify, such that said semiconductor die contacts each of said pedestals and said solder.

3. (Amended) The method as in claim 1, in which said solder comprises a tin/lead eutectic.

4. (Amended) The method as in claim 1, in which said solder comprises a silver alloy.

5. The method as in claim 1, in which said pedestals each include a height within the range of 1-2 mils.

6. The method as in claim 1, wherein said leadframe is formed of a malleable material and said step of forming comprises mechanically stamping said leadframe to form said pedestals as integral portions of said leadframe which protrude from said surface.

7. The method as in claim 1, in which each of said pedestals includes a shape being one of cylindrical and conical.

8. (Amended) The method as in claim 1, in which said step of providing includes providing said semiconductor die having a top including a semiconductor device formed thereon, sides, and a bottom for contacting said pedestals, and in which said step of introducing includes introducing sufficient solder such that said heating and joining urges portions of said solder to extend at least partially along said sides of said semiconductor die when said bottom contacts said pedestals.

9. The method as in claim 1, in which said semiconductor die includes an integrated circuit formed on a top surface thereof, and said step of joining includes joining a bottom surface of said die to said leadframe such that said bottom surface contacts each of said pedestals.

11. (Amended) An assembly comprising a semiconductor die attached to a surface of a leadframe by solder, said leadframe including at least three pedestals one of protruding from and formed over said surface, each of said pedestals having substantially the same pedestal height, and said semiconductor die contacting each of said pedestals.

12. The assembly as in claim 11, in which said pedestal height lies within the range of 1-2 mils.

13. The assembly as in claim 11, in which said pedestals each include a top portion which contacts said semiconductor die and said top portion includes an area within the range of 490 micron² and 2000 micron².

14. The assembly as in claim 11, in which each of said pedestals are conical in shape and include a base coincident with said surface and an apex which contacts said semiconductor die.

15. (Amended) The assembly as in claim 11, in which said solder comprises a tin/lead eutectic.

16. The assembly as in claim 11, wherein said pedestals each comprise raised portions of said leadframe.

17. The assembly as in claim 11, wherein each of said pedestals are discrete members joined to said surface.

18. The assembly as in claim 11, wherein said leadframe is formed of copper.

19. (Amended) The assembly as in claim 11, wherein said solder comprises a silver alloy.

20. The assembly as in claim 11, wherein said pedestals are substantially cylindrical in shape and include substantially flat tops which contact said semiconductor die.

21. (Amended) The assembly as in claim 11, in which said semiconductor die includes an integrated circuit formed thereon, an opposed bottom surface contacting said solder and said pedestals and facing said leadframe, and sides, and said solder extends at least partially up said sides.

22. (Amended) The assembly as in claim 11, in which said solder laterally surrounds each of said pedestals and is interposed between said semiconductor die and said surface, has a thickness substantially equal to said pedestal height, and therefore contacts said semiconductor die and said leadframe.

23. (Amended) The assembly as in claim 22, in which said semiconductor die includes a top surface including circuitry thereon, an opposed bottom surface contacting said solder and said pedestals and facing said leadframe, and sides, and said solder extends at least partially up said sides.

24. (Amended) The assembly as in claim 22, in which said solder is characterized as being void-free between said semiconductor die and said surface.

REMARKS

Claims 1-24 were pending in the present application. Claims 1-24 have been rejected. Claims 2 and 10 have been canceled and claims 1, 3, 4, 8, 11, 15, 19, and 21-24 are hereby amended. Applicants respectfully request the allowance of each of pending claims 1, 3-9, and 11-24.

With respect to the specific paragraphs of the Office action, applicants offer the following specific remarks in support of the patentability of the claims of the present invention.

I. Rejection of Claims 22 and 24 under 35 U.S.C. § 112

In the Office action, specifically on page 2, second paragraph, claims 22 and 24 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants respectfully submit that this rejection is obviated based on the claims amendments and the remarks set forth below.

Claim 24 depends directly from claim 22, which has been amended responsive to this rejection. As amended, claim 22 no longer recites the phrase "each of said semiconductor die" that was pointed out by the Examiner as being indefinite. Claim 22 now definitely and particularly points out the invention in compliance with 35 U.S.C. § 112, second paragraph. Since claim 24 depends from claim 22, the rejection of claims 22 and 24 under 35 U.S.C. § 112, second paragraph, should be withdrawn.

II. Claim Rejections under 35 U.S.C. §§ 102, 103 under the Davis Reference

In the Office action, particularly on page 2, sixth paragraph, claims 1, 3-7, 10-17, 19-22 and 24 were rejected under 35 U.S.C. § 102(b) as being anticipated by Davis, U.S. Patent No. 5,214,307, hereinafter "Davis". Also in the Office action, on page 7, second paragraph, claims 2, 8, 9, 18 and 23 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Davis. Applicants respectfully submit that each of the claim

rejections under §§ 102 and 103 are overcome based on the claim amendments and the reasons set forth below.

The pending set of claims 1, 3-9 and 11-24, include independent claims 1 and 11. Independent method claim 1 has been amended to recite the features of:

- introducing solder onto said mounting area,
- heating to urge said solder to deform, and
- joining such that said semiconductor die contacts said solder.

Independent claim 11, in amended form, now recites “a semiconductor die attached to a surface of a leadframe by solder”.

On page 8 of the Office action, the Examiner concedes that:

“Davis does not appear to explicitly teach the following:
[Claim] 2. The method as in 1, further comprising the step of heating to urge said adhesive material to deform, and in which said step of joining includes urging said adhesive material to solidify”.

The Examiner then further states, when discussing the adhesive used to join the semiconductor die to the leadframe on page 9, lines 5-6, “nonetheless, Davis teaches that the adhesive material is solder”. Applicants respectfully disagree with the Examiner’s contention and submit that Davis does not teach solder as the material used to join the semiconductor die to the lead frame. The only mention of solder made in the Davis reference is on column 4, line 32, where Davis states that “the bumps can be stamped or etched during the manufacture of the lead frame, applied to the die paddle by adhesive means such as epoxy, solder, thermoplastic”. This is quite distinguished from using solder to join the semiconductor die to the leadframe surface that includes the bumps/pedestals. Taken together with the Examiner’s concession that Davis does not teach heating to urge the adhesive material to deform, it can be stated that Davis does not suggest the use of solder as the material to join the semiconductor die to the lead frame since the use of solder requires heating for such a deformation. In summary, then, Davis does not teach or suggest using a deformable adhesive material or heating the deformable adhesive material to join the semiconductor die to the leadframe, in general, and, in particular, Davis does not teach or suggest the use of solder to join the semiconductor die to the leadframe.

It is because of the claimed feature of a deformable adhesive material, particularly solder, that the present invention enjoys the following advantage over the relevant art. Since the deformable adhesive material (solder) is heated to deform during the assembly process, the present invention relies much less upon the force exerted by the semiconductor die being forced into position, to displace the adhesive. Since less force must be applied to the semiconductor die, the present invention enjoys the advantage of reduced breakage of semiconductor die and also produces a smoother, more continuous and void-free material joining the semiconductor die to the leadframe.

As above, amended independent claim 1 includes features that are not disclosed or suggested in Davis. Therefore, the rejection of independent claim 1, under 35 U.S.C. § 102(a) as being anticipated by Davis, should be withdrawn. Claim 2 has been canceled, and claims 3-9 remain dependent on independent claim 1. Claims 3 and 4 have been amended to recite particular solder materials, and claim 8 has been amended for consistency with the amendment to claim 1. Since dependent claims 3-9 each depend from independent claim 1, which is distinguished from the reference of Davis for reasons set forth above, each of claims 3-9 is therefore in patentable form. The rejection of claims 3-7 under 35 U.S.C. § 102(b) as being anticipated by Davis, should therefore be withdrawn. Similarly, the rejection of claims 8 and 9 under 35 U.S.C. § 103(a) as being unpatentable in view of Davis, should also be withdrawn.

Amended independent claim 11 recites the feature of “a semiconductor die attached to a surface of a leadframe by solder”.

As pointed out above, applicants again submit that Davis does not teach solder, or any other deformable adhesive material for that matter, for joining a semiconductor die to the surface of a leadframe. In fact, the Examiner concedes that Davis does not teach heating to urge the adhesive material to deform and such operation would be necessary if solder were used. Davis therefore does not teach or suggest solder and amended independent claim 11 therefore recites features neither taught nor suggested by Davis, and is therefore distinguished from Davis and in patentable form. Claims 12-24 each depend, directly or indirectly, from amended claim 11, and therefore also recite features neither taught nor suggested by Davis and which therefore distinguish the applicants' invention from Davis. Claims 15 and 19 have been amended to recite specific solder embodiments and claims 21-24 have been amended for consistency with the amendment to independent claim 11.

Therefore, the rejection of each of amended claims 11, 15, 19, 21-24 and claims 12-14, 16-18 and 20, under 35 U.S.C. §§ 102 and 103, should be withdrawn. In particular, the rejections of claims 11-17, 19-22 and 24 under 35 U.S.C. § 102(b) as being anticipated by Davis, should be withdrawn. Since amended independent claim 11 includes features neither disclosed or suggested by Davis, the rejection of claims 18 and 23 under 35 U.S.C. § 103(a) as being unpatentable over Davis, should also be withdrawn.

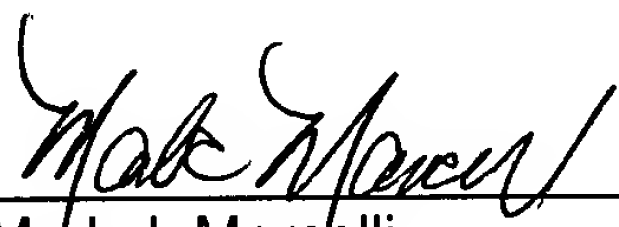
CONCLUSION

For the reasons set forth above, each of claims 1, 3-9 and 11-24 are in allowable form, and the application is therefore in condition for allowance, which action is respectfully requested by applicants.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned **Version with Markings to Show Changes Made.**

Respectfully submitted,

CHRISTIE, PARKER & HALE, LLP

By 
Mark J. Marcelli
Reg. No. 36,593
626/795-9900

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